IMPROVING TRIANGLE GEOMETRY SHAPE FEATURES THROUGH TRIANGLE POINTS SELECTION IN DIGIT RECOGNITION

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DECLARATION

I declare that this thesis entitled “Improving Triangle Geometry Shape Features Through Triangle Points Selection In Digit Recognition” is the result of my own research except as cited in the references. The thesis has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

Signature : ……..

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Date : ……..……

APPROVAL

I hereby declare that I have read this thesis and in my opinion this thesis is sufficient in term of scope and quality for the award of Master of Science in Information and Communication Technology.

Signature	:	..…….
Supervisor Name	:	DR. MOHD SANUSI BIN AZMI
Date	:	……..……

DEDICATION

I would like to dedicate my work to my beloved family especially to my parent for their non-stop supporting and teaching me since I was born. Also to my siblings (Syafwan, Amirudin, Amanina, Mursyid) for always encourage and help me. This work is a guileless and humble reply to their kindness. May Allah bless all of them.

ABSTRACT

Geometry features has been widely used in image processing especially in face recognition, fingerprint recognition, digit recognition, vehicle detection and also in intrusion. Among the commonly used geometry features are the features that are based on triangle properties. Generally, triangle properties can be used to produce the features for image classification. To produce these features, triangle geometry need to be formed based on three coordinates which are the corners of A, B and C. However, not all triangle formations can be formed from the three coordinates due to the condition where corners of A, B and C may cause a straight line problem. The straight line problem occurs when the chosen coordinates of the corners of A, B and C are in a straight line which causes the triangle geometry impossible to be formed. On the other hand, the straight line occurs when the gradient of corners A, B and C produces the equivalent value. This can be proved by the experiment conducted to identify the gradient that has equivalent value where the position of coordinates A, B and C will determine either the triangle can be formed or vice versa. The purpose of this study is to suggest an improvement on triangle geometry shape through triangle point selection. To achieve this purpose, there are two objectives suggested for this study. They are: i) to propose straight line detection technique for corner A, B and C of triangle; and ii) to improve triangle shape by proposing location of corners based on dominant distribution of foreground image. In the experiment, four types of digit dataset are chosen which are IFCHDB, HODA, MNIST and BANGLA where each datasets is consisted of testing data and training data. The Detection of Triangle Point Selection (DTPS) is proposed to detect the triangle point that caused a straight line to be formed. Then, the straight line problem is solved using Triangle Geometry Based Dominant Distribution of Foreground Image (TD^2FI). Next, the Triangle Features Based Summation of Gradient and Ratio (TSGR) and Enhancement of Proposed Triangle Features using Absolute Value (EFTA) are proposed in order to improve the classification accuracy result. The experimental results are yielded by comparing the results of classification accuracy between the present proposed methods with a prior proposed method using the supervised machine learning (SML). The SML used are the Support Vector Machine (SVM) and the Multi-Layer Perceptron (MLP). The result of classification accuracy has shown impressive results for TD^2FI, TSGR and EFTA methods through the SVM and MLP techniques whereas the datasets from IFCHDB, HODA and BANGLA respectively have acquired good results through the SVM technique while MNIST dataset has acquired the highest result of classification accuracy through the MLP technique. The result of classification accuracy for TD^2FI is 94.723% from IFCHDB dataset, 97.295% from HODA dataset, 95.4% from MNIST dataset and 90.275% from BANGLA dataset. In conclusion, the proposed method is capable of outstripping the straight line issue based on the position of the coordinates of corners A, B and C as well as produce a better result for classification accuracy.

ABSTRAK

Fitur-fitur segi tiga telah digunakan dengan meluas dalam pemprosesan imej terutamanya pada pengecaman wajah, pengecaman cap jari, pengecaman digit, pengesanan kenderaan dan juga dalam pencerobohan. Satu daripada fitur-fitur geometri ialah fitur yang berdasarkan fitur-fitur segi tiga. Pada umumnya, fitur-fitur segi tiga boleh digunakan untuk menghasilkan fitur untuk pengelasan imej. Untuk menghasilkan fitur, geometri segi tiga perlu dibentuk berdasarkan tiga koordinat iaitu sudut A, B dan C. Walau bagaimanapun, tidak semua pembentukan segi tiga akan dibentuk daripada tiga koordinat kerana sudut A, B dan C boleh menyebabkan masalah garis lurus. Masalah garis lurus berlaku apabila koordinat-koordinat yang terpilih iaitu sudut A, B dan C berada dalam keadaan garis selari yang mana menyebabkan geometri segi tiga mustahil untuk dibentuk. Dalam erti kata lain, garis lurus ini berlaku apabila nilai kecerunan sudut A, B dan C adalah sama. Ini boleh dibuktikan berdasarkan eksperimen yang telah dijalankan untuk mengenal pasti kecerunan yang mempunyai nilai yang sama di mana kedudukan koordinat A, B and C akan menentukan sama ada segi tiga boleh ditubuhkan dan sebaliknya Tujuan kajian ini adalah untuk mencadangkan penambahbaikan pada bentuk geometri segi tiga dengan menggunakan titk-titik segi tiga yang terpilih. Bagi mencapai tujuan ini, terdapat dua objektif dicadangkan untuk kajian ini. Objektifnya ialah i) mencadangkan teknik pengesanan garis lurus bagi sudut A, B dan C segi tiga; dan ii) menambahbaik bentuk segi tiga dengan mencadangkan lokasi sudut berdasarkan taburan dominan imej latar depan. Dalam eksperimen, empat jenis digit set data dipilih iaitu IFCHDB, HODA, MNIST dan BANGLA dimana setiap set data terdiri daripada data uij dan data latihan. Pengesanan Titik Segitiga Pemilihan dicadangkan untuk mengesan titik segitiga yang menyebabkan garis lurus terhasil. Kemudian, masalah garis lurus diselesaikan dengan menggunakan Segitiga Geometri Menggunakan Taburan Dominan Imej Latar Depan (STDIL). Seterusnya, Fitur Segitiga Berdasarkan Jumlah Bagi Kecerunan dan Nisbah (FJKN) dan Penambahbaikan Fitur Segitiga Cadangan Menggunakan Nilai Mutlak (PSCM) di cadangkan bagi meningkatkan keputusan pengklasifikasian ketepatan. Keputusan pengklasifikasian ketepatan akan dibandingkan antara cadangan sebelum ini dengan cadangan kajian ini dengan menggunakan Pembelajaran Mesin Terselia (PMT). PMT yang digunakan ialah Pembelajaran Mesin Sokongan Vektor (PMSV) dan Perseptron Multi-Aras (PMA). Keputusan pengklasifikasian ketepatan telah menunjukkan keputusan yang baik bagi kaedah STDLI, FJKN dan PSCM melalui teknik PMSV dan PMT dimana set data IFCHDB, HODA dan BANGLA telah memperolehi keputusan yang tertinggi melalui teknik PMSV manakala set data MNIST melalui teknik PMA. Keputusan ketepatan bagi STDLI menunjukkan keputusan yang baik iaitu 94.723% untuk IFCHDB, 97.295% untuk HODA, 95.4% untuk MNIST dan 90.275% untuk BANGLA. Kesimpulannya, kaedah-kaedah yang dicadangkan mampu mengatasi isu garis lurus berdasarkan kedudukan koordinat sudut A, B dan C serta menghasilkan keputusan ketepatan yang lebih baik.

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LIST OF ABBREVIATIONS

DTPS	-	Detection of Triangle Point Selection
EFTA	-	Enhancement of Proposed Triangle Features Using Absolute Value
ETSG	-	An Enhancement of Triangle Shape Using Triangle Geometry
LIBSVM	-	Library Support Vector Machine
SSPS	-	Statistical Solution Problem Software
SVM	-	Support Vector Machine
TD^2FI	-	Triangle Geometry Using Dominant Distribution of Foreground Image
TSGR	-	Triangle Feature Based Summation of Gradient and Ratio
WEKA	-	Waikato Environment for Knowledge Analysis

LIST OF PUBLICATIONS

Azmi, M.S., Arbain, N.A., Muda, A.K., Abal Abas, Z., and Muslim, Z., 2015. Data Normalization for Triangle Features by Adapting Triangle Nature for better Classification. *2015 IEEE Jordan Conference on Applied Electrical Engineering and Computing Technologies*, pp.1–4.

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CHAPTER 1

INTRODUCTION

1.1 Introduction

Digit recognition is an area which has been actively explored particularly to identify manuscript origin details such as originality, writing date, provenance, as well as number of authors (Chaudhuri, 2006; Bulacu et al., 2007; Pan et al., 2009). The studies in digit recognition for ROMAN characters handwriting was explored over four decades ago (Knoll, 1969). In meantime, no publicly was available for standard datasets that can be used by the researchers. However, the researches and development in digit recognition was gone on a swift expansion in the last decade. The Modified NIST dataset (MNIST) was a largest dataset for ROMAN handwriting has been developed as a result of handwritten digit classification competition which has been held in summer of 1992 (Borji et al., 2008). The studies of digit recognition had evolved rapidly along with improvement made on prior methods and techniques (Sundaresan and Lin, 1998; Liu et al., 2003, 2004; Kussul and Baidyk, 2004; Labusch et al., 2008, 2010; Moradi et al., 2010; Mirsharif et al., 2012).

In digit recognition, the image datasets used which include CEDAR, MNIST, HODA, BANGLA and IFCHDB (Bhowmik et al., 2004; Kussul and Baidyk, 2004; Verma et al., 2004; Alaei et al., 2009; Javidi and Sharifizadeh, 2012; M. S. Azmi, 2013). Since images are used, image processing is required to process the images, for example to convert image into binary pixels. Image processing is one of the vital elements

that is widely used in research area within engineering and computer science disciplines. Among rapidly growing technology today, various applications were developed in order to conduct a process of pre-processing of the selected images such as remote sensing, medical diagnosis, industrial applications, robotics, and so on and so forth. These applications are used to assist researchers to handle the process of feature extraction in image processing.

Feature extraction is an important stage where the input data will be converted into a reduced sets of feature when the input data to an algorithm is too big to be handled. In other words, the input data are transformed into a reduced sets of feature vector (Huang and Zhou, 2010). This process is a vital stage generating feature vectors. If extracted features are chosen correctly, the feature sets will consist of important information from input data. This enable to analyse following tasks by using the reduced sets rather than the whole size of input. There are several techniques are frequently used to extract images such as Image Processing Basics, Sobel Edge Detection, Canny Edge Detection and Hough Transformation (Aichert, 2008).

Recently, the triangle geometry method has been used to extract images. M. S. Azmi (2013) had proposed new features from triangle properties by using the triangle geometry method to extract digit images. The triangle geometry method also has been extensively applied in biometric research such as face recognition and fingerprint recognition (Jin et al., 2009; Tin et al., 2009; Lai and Suandi, 2011; Gao and Xu, 2012). Besides, the triangle geometry also had been adopted in intrusion, vehicle detection and digit recognition (Mozaffari et al., 2007; Haselhoff and Kummert, 2009; Ebrahimpour et al., 2010; Tang et al., 2010; M. S. Azmi, 2013).

In triangle geometry, three points of triangle are required in forming a triangle shape. However, problem in determining three points of triangle had caused modelling problems. The problem occurred when the value of gradient for the generated three points

of triangle are equivalent and causing the three points of triangle's position to be inline. The inline position for three points of triangle eventually leads to the formation of a straight line.

Thus, this study aims to solve the problem in determining three triangle points. The triangle points need to be identified to form a triangle shape. Selected triangle points are to be used to assist in producing the proposed method for triangle formation solution in solving straight line problem. The solution to straight line problem is proposed in order to improve the triangle geometry shape through three triangle points. The validation of proposed method is carried on in order to evaluate the performance of the proposed method.

1.2 Research Background

Feature extraction is an important task in image processing because of the meaningful features extracted are vital in representing an object. Object is modelled and represented by geometric forms through geometrical properties. The triangle geometry properties such as angles of corners, ratios of sides and gradients of corners can be used to produce triangle features. Thus, triangle shape needs to be formed to acquire triangle properties. A triangle can be formed based on three points that linked to each other. (Page, 2015).

The triangle geometry method has been widely used in recognition area such as face and fingerprint recognition. In face recognition, triangle points are acquired based on body elements such as nasal tip, eyes, nose and mouth (Tin et al., 2009; Gao and Xu, 2012; Zhang et al., 2012). For fingerprint recognition, triangle points are attained based on minutiae (Ghazvini et al., 2011; Gago-Alonso et al., 2013; Yang et al., 2013; Kavati et al., 2014; Jadied, 2015; Jain and Prasad, 2015).